DTU Library

Fabrication of nanostructures on double-curved PMMA surfaces by thermal imprint with PDMS stamp

Christiansen, Alexander Bruun; Cech, Jiri; Kristensen, Anders; Taboryski, Rafael Jozef

Publication date:
2011

Citation (APA):
Christiansen, A. B., Cech, J., Kristensen, A., & Taboryski, R. J. (2011). *Fabrication of nanostructures on double-curved PMMA surfaces by thermal imprint with PDMS stamp*. Poster session presented at The 55th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication, Las Vegas, Nevada, USA.

Fabrication of nanostructures on double-curved PMMA surfaces by thermal imprint with PDMS stamp

A. B. Christiansen, J. Cech, A. Kristensen and R. Taboryski
DTU Nanotech, Technical University of Denmark
Alexander.Christiansen@nanotech.dtu.dk

We present a method for imprinting nanostructures in double-curved PMMA surfaces, using an elastic PDMS stamp and a hydrostatic press. Features of sizes down to 420 nm are imprinted onto 280 μm high spherical caps with a radius of curvature of 1 mm and a baseline diameter of 1.4 mm on an otherwise planar substrate. Conformal contact between an intrinsically planar stamp and a double-curved substrate requires a tensile strain on the neutral plane of the stamp. Our results show an increase in the pitch of the imprinted pattern of 20% compared to the unstrained stamp.

There is an increasing interest in methods for patterning double-curved substrates for various purposes, e.g. anti-reflective structures on micro-lenses. Zhang *et al.*[1] imprinted a grating with a period down to 820 nm, on a spherical substrate with a 49 mm radius of curvature, using capillary force lithography. Cheng *et al.*[2] used gas pressure and a UV curable resist to imprint 600 nm features on a substrate with 57.5 mm radius of curvature. Choi *et al.*[3] used a PDMS stamp to imprint 350 nm features on 10 mm radius of curvature spherical substrates.

A planar aluminium substrate with a single spherical protrusion was spincoated with 350k PMMA (T_g=105 °C) in anisole and baked at 150 °C for 5 minutes. The substrate was imprinted with a nanostructured PDMS stamp, by applying a hydrostatic pressure on the backside of the stamp (Obducat Eitre® 3). This allows the stamp to conform to the PMMA substrate and apply a uniform pressure over the curved surface. The imprint was made at 10 bar pressure, at 120 °C for 10 minutes.

The imprinted PMMA surface was imaged with AFM (Fig. 1), and the micrographs were analyzed with an image processing program[4]. The imprinted structures were characterized by depth and lateral size and period. These results were recorded at different distances to the apex of the protrusion (Fig. 2), and compared to the unstrained stamp. The results show that the pitch of the imprinted features is strained up to 20% at the apex of the protrusion (Fig. 3).

---

[1] Zhang *et al.* Optics Express **18** (2010) 15009
[2] Cheng *et al.* J. Vac. Sci. Technol. B **24** (2006) 1724
[3] Choi *et al.* Nanotechnology **15** (2004) 1767
[4] *http://www.imagemet.com*

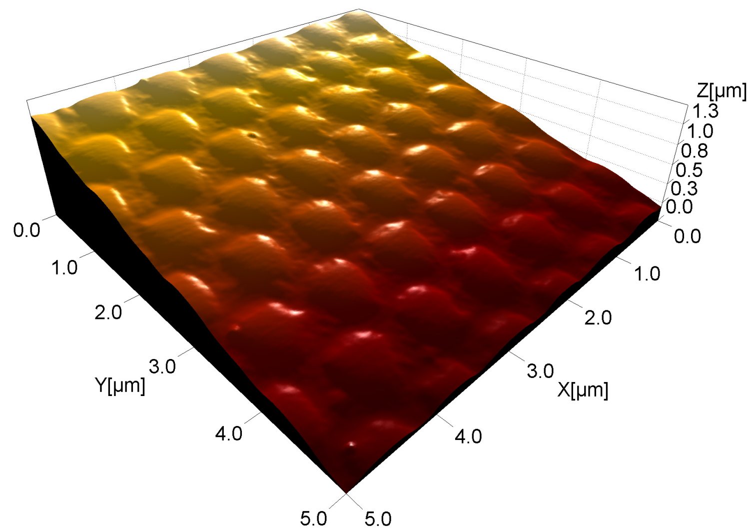

Figure 1: Atomic force micrograph of the imprinted surface. The image was recorded at position B on Fig. 2. The average height of the imprinted structures is 64 nm.

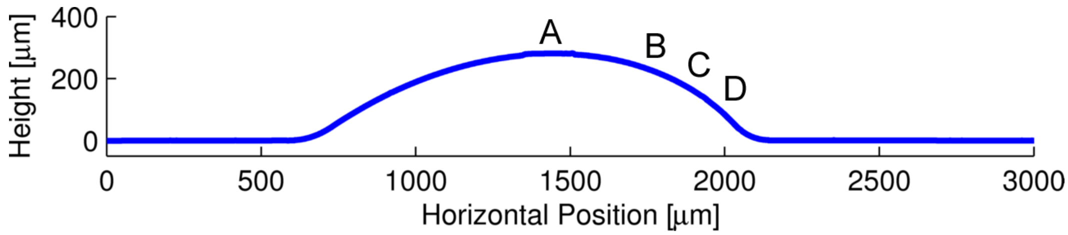

Figure 2: Profile of the imprinted surface. The radius of curvature is 1mm, total height is 280 μm and the diameter is 1400 μm. Well defined imprints are obtained at positions A, B and C.

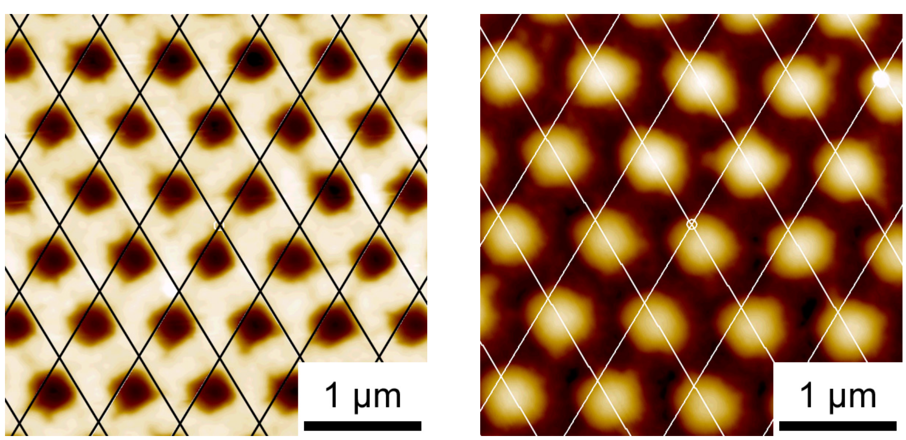

Figure 3: An example of unit cell identification to estimate the pitch of the imprinted features. *Left:* AFM image of the PDMS stamp. Mean pitch is 670 nm. *Right:* AFM image of the imprinted surface at the apex (A in Fig. 2). Mean pitch is 820 nm.